WEATHER SERVICES

Weather Services encompass the wide range of analysis and prediction products and forecast, warning and information services to the general public, national and international shipping and aviation, the Department of Defence and other users. Services are provided mainly through the seven Regional Forecasting Centres (RFCs) in the State capital cities and Darwin, and through the National Meteorological and Oceanographic Operations Centre (NMOC) located in Melbourne. All of these Centres maintain a 24-hour weather watch every day of the year, issuing forecasts, warnings and other weather information as required.

Many of the Bureau’s offices in rural and remote areas, which function primarily to provide high quality weather observations (surface, upper air and weather watch radar), have an important complementary role in providing current weather information and a range of other services to their local communities. Some 43 such service outlets are distributed across Australia, with a further two at Australian bases in Antarctica.

Most of the Bureau’s weather services are made available to the Australian community through the mass media (radio, television, newspapers) and services are also accessible via the Internet, recorded telephone systems, marine high frequency (HF) radio and facsimile, and Inmarsat (marine) satellite broadcasts.

A broad range of ongoing consultative mechanisms, involving Commonwealth and State authorities and major commercial and community user groups, is in place to help ensure that services evolve and are continually improved in accordance with user needs and advances in science and technology.
## PLANNED OUTCOME 2006-07

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Enhanced community safety and well-being through preparation of meteorological and related products and information and the effective use of meteorological and related services by the general public and other major social, environmental and economic sectors.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Objective</td>
<td>To meet the needs of the general public and specialised users for relevant, accurate and timely weather data, information, forecast and warning services.</td>
</tr>
<tr>
<td>Effectiveness indicators</td>
<td>The extent to which:</td>
</tr>
<tr>
<td></td>
<td>• meteorological and related services contribute to:</td>
</tr>
<tr>
<td></td>
<td>- minimising loss of life and property and community disruption from bushfires, tropical cyclones and severe storms;</td>
</tr>
<tr>
<td></td>
<td>- minimising economic and other costs of disaster preparedness;</td>
</tr>
<tr>
<td></td>
<td>- the safety, comfort, convenience and general welfare and economic benefit of the public and major community groups;</td>
</tr>
<tr>
<td></td>
<td>- the safety and efficiency of shipping, small craft and maritime industries;</td>
</tr>
<tr>
<td></td>
<td>- the safety, regularity and efficiency of air navigation;</td>
</tr>
<tr>
<td></td>
<td>- the efficiency and effectiveness of the Australian Defence Force;</td>
</tr>
<tr>
<td></td>
<td>- government and community planning;</td>
</tr>
<tr>
<td></td>
<td>- the management of the environment, including natural resources; and</td>
</tr>
<tr>
<td></td>
<td>- the economy and efficiency of primary and secondary industry;</td>
</tr>
<tr>
<td></td>
<td>• forecasts, warnings, information and advice are accurate and timely;</td>
</tr>
<tr>
<td></td>
<td>• user needs (including the needs of specific users of special weather services on a cost recovery basis) are identified and, within available resources, are satisfied and new services and products are developed as opportunities arise;</td>
</tr>
<tr>
<td></td>
<td>• the public, major user groups and specialised users receive, understand and make optimum use of the services and express satisfaction with the services;</td>
</tr>
<tr>
<td></td>
<td>• the NMOC provides reliable, timely analysis and forecast guidance products that impact positively on the quality of services; and</td>
</tr>
<tr>
<td></td>
<td>• the NMOC and the RFCs provide, in combination, a sufficiently comprehensive and responsive nationwide and regional scale weather watch operation to detect and react immediately to the first evidence of developing dangerous weather and provide a foundation for the provision of routine basic and special weather services.</td>
</tr>
</tbody>
</table>
The Weather Services output is one of the Bureau’s eight major outputs and contributes towards Output 1.3 - Meteorological and Related Services and Products. Outputs from this group typically include analysis and prediction products describing the state of the atmosphere, information on current and forecast weather conditions for States, districts, cities and towns for dissemination through the mass media and use by the community at large; public warnings of severe weather events; user-specific forecasts, warnings and information, tailored to meet the sectoral needs of the marine, agricultural, aviation and defence communities; and specialised weather information, forecast and warning services, provided on a cost-recovery basis, to meet the specific requirements of individual clients and user groups.

### OUTPUT PERFORMANCE 2006-07

<table>
<thead>
<tr>
<th>Quality</th>
<th>Target</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Percentage of users surveyed indicating that public weather forecasts and warnings are substantially accurate</td>
<td>90%</td>
<td>94%</td>
</tr>
<tr>
<td>Percentage of users surveyed indicating that public weather forecasts and warnings are becoming more accurate or are maintaining current levels of accuracy</td>
<td>90%</td>
<td>91%</td>
</tr>
<tr>
<td>Percentage of users surveyed indicating that they are satisfied or very satisfied with weather forecast, warning and information services</td>
<td>90%</td>
<td>91%</td>
</tr>
<tr>
<td>Percentage of users surveyed indicating that weather forecasts, warnings and information services are received in time for them to make their decisions</td>
<td>90%</td>
<td>95%</td>
</tr>
<tr>
<td>Percentage downtime for Internet access services</td>
<td>0.1%</td>
<td>0.0%</td>
</tr>
<tr>
<td>Percentage of numerical guidance products delivered before the scheduled deadlines for dissemination</td>
<td>95%</td>
<td>99%</td>
</tr>
<tr>
<td>Percentage of users satisfied with the value of forecast guidance product components</td>
<td>90%</td>
<td>86%</td>
</tr>
<tr>
<td>Accuracy of centralised analysis and forecast guidance products as measured by statistical evaluation procedures:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>- gain in skill of model forecasts over persistence (points)</td>
<td>30</td>
<td>37</td>
</tr>
<tr>
<td>- error in 24-hour statistical guidance for maximum temperatures (°C)</td>
<td>3</td>
<td>1.8</td>
</tr>
<tr>
<td>- error in 24-hour statistical guidance for minimum temperatures (°C)</td>
<td>2.5</td>
<td>1.5</td>
</tr>
<tr>
<td>- 72, 120 and 168-hour Anomaly Correlations</td>
<td>75%, 55%, 40%</td>
<td>83%, 61%, 48%</td>
</tr>
<tr>
<td>- error in 24-hour sea state predictions (m)</td>
<td>0.7</td>
<td>0.56</td>
</tr>
</tbody>
</table>
## OUTPUT PERFORMANCE 2006-07 CONT.

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Target</th>
<th>Actual</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of public weather warnings issued</td>
<td>15,000-20,000</td>
<td>21,507</td>
</tr>
<tr>
<td>Number of public weather forecasts and information bulletins issued</td>
<td>300,000-350,000</td>
<td>261,130</td>
</tr>
<tr>
<td>Number of accesses by telephone/facsimile for automated weather service delivery systems</td>
<td>5-7 million</td>
<td>3,346,902</td>
</tr>
<tr>
<td>Number of accesses by the internet for automated weather service delivery systems</td>
<td>4 to 4.5 billion</td>
<td>14.4 billion</td>
</tr>
<tr>
<td>Number of Regional Forecasting Centres</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Number of numerical guidance products issued by NMOC</td>
<td>2,400</td>
<td>2,359</td>
</tr>
<tr>
<td>Number of numerical weather prediction systems providing distinct guidance products</td>
<td>10</td>
<td>18</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Price</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis and Prediction Products</td>
<td>$6.287m</td>
</tr>
<tr>
<td>Disaster Mitigation Activities</td>
<td>$5.233m</td>
</tr>
<tr>
<td>Public Weather Services</td>
<td>$14.335m</td>
</tr>
<tr>
<td>Marine Weather Services</td>
<td>$1.507m</td>
</tr>
<tr>
<td>Aviation Weather Services</td>
<td>$15.353m</td>
</tr>
<tr>
<td>Defence Weather Services</td>
<td>$3.357m</td>
</tr>
<tr>
<td>Cost Recovery Services</td>
<td>$3.841m</td>
</tr>
</tbody>
</table>

### Comments on output performance

User surveys showed that the community relied increasingly on the internet to access Bureau services but still continued to use radio and television as the primary source for access to essential warnings. The surveys consistently indicate that the Bureau’s services are held in high regard by the Australian community. Quality targets were exceeded against almost all indicators. Of particular note was the continued high level of public regard for the accuracy of the Bureau’s weather forecast services (94 per cent), and the acknowledgement of improving accuracy.

The number of hits on the Bureau’s radar web pages increased by 55 per cent relative to 2005-06. Accesses to weather services by telephone decreased, and were again below target, reflecting the increased preference of the public to use new technologies, particularly internet-based information systems.

The number of numerical guidance products issued by NMOC at 2359 was comparable with that in 2005-06, and slightly below the target figure. This is in part due to the way in which numerical guidance products are counted, which was changed in 2004-05 so that a forecast product issued for several different lead-times, such as +6, +12, and +24 hours, is counted as a single product. This performance target is being reviewed.
The percentage of users satisfied with forecast guidance products was somewhat below target. The survey of forecasting staff from which the measure is derived indicated an increasing preference for guidance products from international sources. The planned replacement of local numerical prediction models with a version of the UK Met Office model is intended to address this trend.

Expenditure on Marine Weather Services exceeded the target due to the reallocation of a number of staff from Public Weather Services during the year. This reallocation more accurately reflects the duties performed by staff in the RFCs and provides a more workable management structure in each Regional Office. Expenditure in Public Weather Services consequently decreased and was somewhat below the target for the financial year. The expenditure on Cost Recovery Services is not reported separately due to a rearrangement of the Bureau of Meteorology's output structure at the start of 2006-07 under which such services were no longer separately identified. Cost recovery was instead regarded as an inherent component of the activities of all outputs.

ACHIEVING THE OUTCOME

Weather Services are delivered through six individual outputs that contribute to the achievement of the desired outcome. The developments in each individual output during 2006-07 and their contributions to the outcome are considered below.

OVERVIEW OF 2006-07

The forecast period shown in the new tropical cyclone forecast map was extended to improve the effectiveness of tropical cyclone warnings by providing longer lead times for emergency services and community planning. This innovation received excellent community feedback. Upgrading of the weather watch radar coverage continued with the new high resolution radar at Mt Stapylton, near Brisbane. A new web based service called “Water and the Land” was launched drawing together information of relevance to primary industry and natural resources managers. The response from the public, especially farmers, was again very positive.

To extend and improve the Bureau’s range of services and allow wider access by the community, the Forecast Streamlining and Enhancement Project (FSEP) continued development of the Graphical Forecast Editor (GFE). Working with US National Oceanic and Atmospheric Administration (NOAA) scientists, the Bureau has developed first stage prototype systems that will be implemented in its operations over the next two years. This forecasting system is expected to support an extended range of services right across Australia, including the eventual production of an Australian Digital Forecast Database that will be accessible via the web. It will enable the development of new, modified and value-added products that will enhance outcomes for the community.
ANALYSIS AND PREDICTION PRODUCTS

The analysis and prediction outputs flow from the basic meteorological operations of analysis of real-time datasets to establish the current state of the atmosphere, and subsequent prediction of its evolution out to about eight days ahead. These operations are essential to the provision of weather, climate and oceanographic services and to fulfil Australia’s international obligations under the Convention of the World Meteorological Organization (WMO). The NMOC in Melbourne, the Regional Specialised Meteorological Centre in Darwin, the seven RFCs in the State capital cities and Darwin, the Townsville and Canberra Meteorological Offices, and the Antarctic Meteorological Centre at Casey function as an integrated national network to produce a range of manual and automated guidance products which support the nationwide operational forecast and warning services provided by the Bureau.

The NMOC serves as the central operational hub, combining the roles of operational communications and computing with meteorological and oceanographic analysis and prediction functions. The NMOC runs several complex numerical analysis and prediction systems to provide current or predicted conditions in the atmosphere or the ocean, with differing emphasis according to the various applications. Figure 20 shows the improvement in the prediction skill of the numerical models over time.

![Figure 20](image_url)

*Figure 20. Values for the S1 skill score, a measure of the errors in prediction, for 24-hour forecasts of mean sea level pressure from operational and persistence prognoses over the Australian region. The values shown are 12-month running means. The persistence predictions, based on the assumption that today’s pattern will continue unchanged tomorrow, show relatively large errors and no long-term trend. The operational predictions from the Australian region analysis and prediction system have shown general improvement over time. The original base analysis used for verification purposes has been discontinued. The results during the overlap period show a slight shift in the measure of skill, but the trends are similar.*
Major developments 2006-07

- The so-called Poor Man's Ensemble (PME) system was introduced in August and combines rainfall forecasts from the Bureau's numerical prediction systems with those from other international centres to create forecasts of rainfall amount based on the mean of the individual forecasts. The probability of certain amounts of rainfall is also calculated, based on the proportion of models forecasting this amount.

- New tsunami bulletins were introduced in December by the NMOC. The bulletins are issued quickly whenever international tsunami warnings are broadcast by the Pacific Tsunami Warning Centre (PTWC) in Hawaii, and provide emergency managers and the public with a simple assessment of the level of threat to Australia. Figure 21 shows the process by which the tsunami bulletins are produced.

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**Figure 21. Flowchart showing the flow of information involved in the production of a tsunami bulletin after the occurrence of a seismic event. The PTWC is the Pacific Tsunami Warning Centre in Hawaii.**
Contribution towards outcome

- The PME system has shown significantly greater skill in rainfall forecasts than each of the individual models referenced separately. Improved accuracy in this guidance results in improved quality of public forecasts and warnings and is of particular significance to agriculture.
- The new tsunami bulletins enhance community safety by avoiding over-reaction to earthquakes that pose no threat to Australia. In this way the number of false alarms is reduced and the response to real threats is likely to be more effective.

DISASTER MITIGATION ACTIVITIES

Disaster Mitigation Activities assist the community in preparing for and reducing the impacts of tropical cyclones, severe storms, bushfires, floods, tsunami and gales over land. These services are provided through the RFCs, with national coordination by the Head Office Weather and Ocean Services Policy Branch, and through very close links with State and Commonwealth emergency services and disaster preparedness organisations. An important complementary role is to contribute substantively to national and international disaster mitigation and hazard awareness programs, with particular attention to improving effective communication of warnings, developing community awareness of hazards and documenting the risk of natural disasters.

Tropical cyclone warning services are provided for northwest, north and northeast Australia from Tropical Cyclone Warning Centres (TCWCs) co-located with the Perth, Darwin and Brisbane RFCs respectively. The accuracy of the tropical cyclone warning service is assessed in terms of the accuracy of forecasts of cyclone position and intensity (Figures 22 and 23). The planning and operation of the tropical cyclone warning service is closely linked to, and coordinated with, emergency services organisations in Western Australia, the Northern Territory and Queensland to maximise the effectiveness of community preparedness and response.

The Bureau provides forecasts of severe thunderstorms, which are particularly intense convective storms producing destructive winds, damaging hail, tornadoes and/or heavy rain leading to flash flooding, in the form of Severe Thunderstorm Warnings. The accuracy of severe thunderstorm warnings is assessed in terms of the Probability of Detection and the False Alarm Ratio (Figure 24). The Probability of Detection (POD) measures the percentage of events that were forecast, whereas the False Alarm Ratio (FAR) measures the fraction of forecasts for which no event was observed. Severe Weather Warnings are issued for conditions such as land gales, dangerous surf and blizzards that may not necessarily be associated with thunderstorms.

The fire weather warning service provides the public with routine forecasts of fire danger during the fire season, and fire weather warnings when the fire danger is expected to exceed a certain critical level. It also provides fire management authorities and emergency services with detailed routine forecasts, fire weather warnings and operational forecasts to assist in combating ongoing fires. This service includes special forecasts for hazard reduction burns and other advice to assist the assessment and management of fire risk and, in some cases, when practical, out-posted support provided by Bureau staff located at fire
Figure 22. Average errors in tropical cyclone location in the Australian region compared with post-event best estimates. The three lines show the accuracy of real-time estimation (00 hrs) and forecasts (12 hrs and 24 hrs). The associated straight lines show the long-term trend.

Figure 23. RMS errors in tropical cyclone intensity (central pressure) in the Australian region compared with the post-event best estimates. The three lines show the accuracy of real-time estimation (00 hrs) and forecasts (12 hrs and 24 hrs). The associated straight lines show the long-term trend.
Figure 24. Nationally-averaged values of Probability of Detection (POD – fraction of events for which advance warning was provided, ideally 1) and False Alarm Ratio (FAR – fraction of warnings that were false alarms, ideally 0) for the past 14 years (1993 – 2007) for severe thunderstorm warnings. The columns show the total number of observed events for the year. While the FAR has increased slightly, the ability to detect events, indicated by the total observed, has more than doubled over this period.

Figure 25. Nationally-averaged values of Probability of Detection (POD – fraction of events for which advance warning was provided, ideally 1) and False Alarm Ratio (FAR – fraction of warnings that were false alarms, ideally 0) for the past 14 years (1993-2007) for fire weather warnings.
management operations centres. The accuracy of fire weather warnings is assessed in terms of the Probability of Detection and the False Alarm Ratio (Figure 25).

**Major developments 2006-07**

- The introduction of an improved tropical cyclone forecast product generation system enabled the period covered by the tropical cyclone forecast track map to be extended to 48 hours and more detailed information to be disseminated on forecast locations for any tropical cyclone.

- A workshop on weather forecast and warning terminology was conducted for radio announcers in the Broadcasting for Remote Aboriginal Communities Scheme (BRACS). Future workshops and training are planned through the Batchelor Institute of Indigenous Tertiary Education.

- The second high resolution capital city Doppler Radar was commissioned at Mt Stapylton, situated mid way between Brisbane and the Gold Coast, and installation and preliminary testing of a similar Doppler radar at Laverton, west of Melbourne, was well advanced by the end of the year. Final testing of the Doppler upgrade to the Yarrawonga, Victoria, radar was near completion. This will lead to improved accuracy in severe thunderstorm warning products. The Charleville, Queensland, radar was replaced by a new radar at Dulbydilla providing more extensive coverage of the Warrego region.

- Graphical severe thunderstorm warning services, already operating in New South Wales, Queensland and Victoria, were developed for South Australia with implementation planned for later in 2007.

- A post-impact analysis and review report on Severe Tropical Cyclone Larry was prepared with contributions from a range of Government agencies, consultants and research disciplines.


- An Australasian Tropical Cyclone Coastal Impacts Program (ATCCIP) Workshop was held in Cairns in November. The workshop focussed on the impacts of the coastal crossing of Tropical Cyclone Larry on 20 March 2006.

- The fire season commenced early over most regions of Australia and record numbers of fire weather warnings and spot fire forecasts were issued by the Bureau. The Bureau sought assistance from the US National Weather Service and the US Bureau of Land Management who provided forecasting staff between February and April. Following the success of this exchange, two Bureau meteorologists assisted during the US fire season.

**Contribution towards outcome**

- The extended forecast period included on the new tropical cyclone forecast map improves the effectiveness of warnings for tropical cyclones by giving a longer lead time for defensive action to be taken.

- Through better understanding of weather terminology, the BRACS radio announcers can
more effectively convey the meaning of Bureau weather forecasts and warnings to their remote community audiences.

- The upgrade to the weather watch radar coverage during 2006-07 has improved the Bureau’s ability to monitor severe weather, particularly severe thunderstorms, and reduced maintenance costs through the replacement of older, less reliable systems. The new high resolution radar at Mt Stapylton will improve the detection and prediction of severe thunderstorms over southeast Queensland, a densely populated area prone to their occurrence. The new radar for the Warrego region provides improved weather watch capability by extending the coverage of the Bureau’s weather watch network that underpins the rainfall and severe storm monitoring service to the community.

- Graphical severe thunderstorm warnings more effectively communicate the areas forecast to be affected by thunderstorms than traditional text or radio messages.

- The Tropical Cyclone Larry report provided a comprehensive and holistic assessment of the environmental and societal impacts of the cyclone in North Queensland, as well as an evaluation of the performance of forecasting and warning systems. The lessons learned have enabled the Bureau to improve its warning procedures and practices so that warning threat areas are more closely targeted to the affected communities.

- The Bureau, as part of the national disaster mitigation infrastructure, is contributing actively to the whole-of-Government disaster mitigation national priorities.

- The ATCCIP allows specialist tropical cyclone researchers and forecasters, emergency

*Some of the US fire weather forecasters who participated in the forecaster exchange project with Australia, in the Victoria Regional Office of the Bureau: Monica Long (seated at the Fire Weather desk) with (from left) John Pendergast (Florida); Kent Prochazka (Texas), Rick Davis (Florida) and Joe Solomon (Oregon).*
managers, policy makers and the interested broader community to collaboratively progress the understanding of the tropical cyclone hazard and the management of the tropical cyclone risk.

- The provision of additional spot fire weather forecasts to fire-fighting agencies during the fire season improved the ability of agencies to combat fires, while also improving fire-fighter and public safety and assisting in the reduction of associated economic and environmental losses. The exchange of US forecasters with Australia has also led to an exchange of knowledge and experience that is being used to improve fire weather services in both countries.

**PUBLIC WEATHER SERVICES**

The Bureau’s Public Weather Services provide a wide range of weather information and forecasting services in the public interest for the benefit of the general community in all Australian States and Territories. Weather forecasts are provided for more than 170 cities and towns and 60 separate forecast districts, according to community needs. The accuracy of the Bureau’s maximum and minimum temperature forecasts has been verified for a number of years and continues to improve (Figure 26).

Public Weather Services are distributed through a variety of channels including the Internet and telephone information systems (Figure 27) as well as the mass media. Products provided include current and recent weather observations from the Bureau’s extensive observing network, satellite and radar imagery, and forecasts of a wide range of meteorological parameters covering geographically distributed localities, together with numerous warnings for weather conditions with the potential to cause loss of life and/or damage to property.

![Figure 26. Trends in the mean modulus of error (°C) in daily maximum and minimum temperature forecast for all capital cities except Darwin.](image)

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The Bureau uses regular user surveys to monitor levels of community satisfaction and understanding of its forecasts, and to keep abreast of community needs for weather services that enhance public safety and support the daily decision making of individuals, households, businesses, community sectors and government organisations.

As part of its strategy of maximising the reach and utility of its public weather services to the community, the Bureau fosters its partnership relationships with the private meteorological sector. The growing range of services provided by private meteorological companies augments and extends the opportunities for the community to access weather services originated by the Bureau. These relationships provide a significant benefit to the community as the channels for obtaining public weather services continue to multiply and diversify with the rapid evolution of communications technologies and delivery systems.

Major developments 2006-07

- A new section on the Bureau’s website, Water and the Land (WATL), was launched, and combined a range of products with relevance to primary industry and natural resources managers. The website was designed to improve navigation and ease of access to the various web pages. Further development is planned in 2007-08.

- A new web viewer for radar images was introduced for the high resolution Doppler radars in Adelaide and Brisbane. The viewer allows users to apply various geographical overlays such as the location of water bodies and catchments to the radar images to enhance the utility of the information and to enable users to more closely identify their own location.

- New nationally consistent and frequently updated weather observation reports were released on the Bureau’s website, along with local extreme wind and temperature readings
reset at midnight each day. A new, more efficient software system underpins the production of these reports.

- During May, Health Alerts for high pollution levels were added to the Sydney forecasts in collaboration with the New South Wales Department of Health and the New South Wales Department of Environment and Climate Change.

**Contribution towards outcome**

- The release of a website dedicated to primary industry and natural resource managers is intended to enhance the productivity and preparedness of people on the land by consolidating relevant weather and climate information across a wide range of timescales, past, present and future. The new pages have resulted in significantly increased user satisfaction, as judged from comments made on a web feedback facility accessible from the WATL home page, and from increased hit rates on pre-existing products since the WATL pages were released.

- The new radar viewer will enable the public to better reference the location of rainfall, or for example potentially damaging thunderstorms, against known geographical features. It enables a better understanding of the location of weather features and will lead to a safer and better-prepared community.

- The provision of a suite of nationally consistent and regularly updated local weather reports will help inform the public in a timely fashion of measurable weather events such as strong wind gusts and heavy rain. The general public have commented favourably on the more “user friendly” format, improved accessibility, and the more consistent presentation of data across state boundaries.

- The addition of Health Alerts for the Sydney area within the daily weather forecast is expected to help raise community awareness and promote communication of the prospect of poor air quality to the general public.

**MARINE WEATHER SERVICES**

Marine Weather Services contribute to the safety and efficiency of shipping and offshore activities through the provision of relevant, accurate and timely marine meteorological services in accordance with the provisions of the International Convention for Safety of Life at Sea (SOLAS), regulations of the WMO and national laws governing safe navigation in Australian waters. Core services provided include: warnings of strong, gale force, storm force and hurricane force winds; forecasts for high seas, coastal waters, bays, harbours and inland waterways; information on current coastal weather; and analyses and prognoses of ocean surface conditions including waves.

A number of dissemination channels are used to communicate with mariners at sea, including Inmarsat satellite broadcasts and HF and VHF radio broadcasts for the dissemination of forecasts and warnings for high seas and selected coastal waters areas. Numerous volunteer, coast guard and state marine agency groups along the Australian coastline also undertake VHF broadcasts, carrying the forecasts and warnings originated by the Bureau’s marine weather service. As the Internet becomes an increasingly important medium through which users access Bureau forecast services, and as the Bureau improves its fore-
casting systems, national consistency in the suite of forecast products available online has also been improved.

**Major developments 2006-07**

- The Bureau announced in December that its heavily used marine HF radio service would continue to operate until at least 2010.
- A new marine wind warning policy was implemented during November, introducing new terminology and categories for wind warnings in coastal waters and high seas areas. This included the use of ‘hurricane force’ and ‘storm force’ terminology in marine warnings. On 27 March the Bureau’s Western Australian and South Australian Regional Forecasting Centres issued the first hurricane force wind warning for high seas under this policy, for waters south of the Great Australian Bight (Figure 28).
- A new ‘Marine Weather Services’ four-page brochure with an emphasis on wind and waves and their inherent variability was published in both print and online versions. A revised ‘Marine Weather Services’ mini-guide for Victoria was also produced.

**Contribution towards outcome**

- The extension of the HF radio service is part of the overall marine communications strategy. This strategy aims to deliver weather services across a diverse range of access channels (web, telephone, fax, radio and satellite) thereby improving user satisfaction and safety.
- The introduction of new wind warning terminology and categories in Bureau marine wind warnings provides the marine community with a nationally consistent marine wind warning service and increases the impact of warnings in extreme conditions, ultimately contributing to the safety of life and craft at sea.

*Figure 28. Satellite image taken 29 March 2007 clearly identifies the low pressure system southwest of Tasmania that prompted the Bureau’s first hurricane force wind warning.*
• The Marine Weather Services brochure and the Victorian Marine mini-guide initiatives were produced to explain what services are available to the general public, and how users can apply these services for their own benefit and safety.

AVIATION WEATHER SERVICES

Aviation weather services enhance the safety, regularity and efficiency of national and international aviation operations through the provision of accurate, timely and relevant forecasts, warnings and information for aerodromes and en-route operations.

During 2006-07, aviation weather services were generated and delivered through the following major service outlets:
• the Bureau’s Aviation Weather Centre in Melbourne;
• each of the Bureau’s capital city RFCs;
• the Sydney Airport Meteorological Unit (SAMU), which is co-located with Airservices Australia;
• the Volcanic Ash Advisory Centre (VAAC) in Darwin, which is one of the nine international centres established as part of the International Civil Aviation Organization (ICAO) International Airways Volcano Watch; and
• the Aviation Meteorological (AvMet) units at Sydney and Brisbane.

The Bureau of Meteorology is required under Section 6 of the Meteorology Act 1955 to perform its functions, which are also listed in the Act, for a range of purposes, including civil aviation. The Bureau of Meteorology is the designated Meteorological Authority for Australia under the Convention on International Civil Aviation, and in accordance with the standards and practices set out in Annex 3 to the Convention and World Meteorological Organization technical regulations, it provides meteorological services to aviation in Australia. In fulfilling this mandate it works closely with Airservices Australia, which is responsible for air traffic management, and the Civil Aviation Safety Authority (CASA), which is responsible for safety regulation of aviation in Australia.

Throughout the year, user consultation and arrangements for ongoing service improvements continued to be coordinated by a variety of committees, working groups and focus groups involving the Bureau, the Department of Transport and Regional Services and related agencies (CASA, Airservices Australia and the Australian Transport Safety Bureau) and representatives of international, domestic and regional airlines, general aviation, and other industry groups. International consultation and coordination occurred through the WMO Commission for Aeronautical Meteorology and its working groups, the ICAO Asia Pacific Air Navigation Planning and Implementation Regional Group and a number of ICAO study groups.

In conjunction with major stakeholders, the Bureau investigated all meteorological incident reports, in order to identify deficiencies in, and explore opportunities to improve the effectiveness of, the aviation weather service.

Major developments 2006-07

• An aviation forecaster competency program was established and the first stage was conducted in conjunction with aviation forecasters in South Australia. Easily assessable, relevant and user-friendly learning resources and reference materials are being devel-
oped to assist with the program.

- A Quality Management Framework Project was established to certify the Aviation Weather Services Program Office and the SAMU under the ISO 9001:2000 Quality Management Standard.
- The Automated Thunderstorm Alert Service (ATSAS) was implemented at Cairns Airport and is operating in a trial mode for Adelaide, Alice Springs, Coolangatta, Perth and Darwin.
- The VAAC introduced a new volcanic ash graphical product (example at Figure 29), and a Daily Volcanic Ash Summary, to further improve the warning given to airlines of the likely distribution and dispersion of ash from volcanic eruptions.

**Contribution towards outcome**

- Competency training and assessment provides the foundation for service-focused, operationally-relevant training and reflects what a professional forecaster would be expected to do while exercising due care on the job. It provides a tool that serves as a benchmark to facilitate the maintenance of required skills and knowledge.
- The adoption of a quality management approach to the delivery of aviation weather services

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**Figure 29. An example of the new volcanic ash advisory product from the Volcanic Ash Advisory Centre. The dashed lines show the expected extent of ash between the surface and 35,000 feet, while the solid lines show the extent of ash between 35,000 and 55,000 feet, and the four graphics depict the expected dispersion of the ash cloud with time, at six-hourly intervals.**

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is an ICAO recommendation and will lead to an improvement on average in the quality of services to the aviation industry internationally.

- ATSAS contributes to the safety of airport ground crew operations during thunderstorm events.
- The improvement of services from the VAAC contributes to the increased safety of airline operations in areas of known volcanic activity.

DEFENCE WEATHER SERVICES

Defence Weather Services enhance the operations of the Australian Defence Force (ADF) through the provision of accurate, timely and relevant meteorological information. Services include the provision of forecasts, real-time meteorological observations and climatological data, meteorological training and professional advice to assist military decision-making processes.

Services are delivered through the following centres:

- the Defence Meteorological Support Unit (DMSU), located in Darwin and providing a 24-hour point of contact and coordination for the ADF within Australia and overseas;
- Defence Weather Service Offices (WSOs) located at Royal Australian Air Force (RAAF) bases at Amberley, Queensland, East Sale, Victoria, Pearce, Western Australia, Tindal, Northern Territory and Williamtown, New South Wales;
- the Defence WSO located at the Army Aviation Centre at Oakey, Queensland; and
- Defence-attributed staff at Townsville Meteorological Office.

The Darwin-based DMSU provides particular expertise in the strategically important areas of tropical Australia, South-East Asia, the Middle East and the southwest Pacific and was established to provide information in a secure environment. The DMSU complements and supports Defence WSOs which provide localised specialist meteorological services to support military aviation. Electronic media, using both the Internet and the Defence Secret Network, are key delivery platforms.

Users were consulted throughout the year as a key part of the process for ensuring the appropriate levels of service. The primary user is the RAAF, which meets the largest part of the annual charge for Defence Weather Services, although the Army is increasing its use of the services.

Major developments 2006-07

- Forecasting support was provided by the DMSU to ADF overseas operations, including the Solomon Islands (Operation Anode), Iraq and Afghanistan (Operations Catalyst and Slipper) and northern Australia surveillance patrols (Operation Resolute).
- Overseas exercise support comprising forecasts and other information, supplied from the DMSU, was also provided to Australian Units participating in exercises run by the defence forces of Papua New Guinea, Singapore, Thailand, Micronesia, US (San Diego) and Malaysia.
- Forecasters from the Defence Weather Service accompanied RAAF squadrons, in support of multinational exercises, to Singapore (Exercise Bersama Padu), Malaysia (Exercise Bersama Shield) and Curtin in Western Australia (Exercises Pitch Black and Aces North).
- Within Australia, major exercise support on a 24 hour, 7 day a week basis, was provided.
for both Australian and visiting defence forces at Shoalwater Bay (Exercises Wallaby and Talisman Sabre).

• The use of the Defence Weather Service web site, which is replicated on the Defence Secret Network, as a platform for delivering services to the ADF, continued to grow with an increase in the monthly download bandwidth from 60GB in January 2006 to 70GB in January 2007.

Contribution towards outcome

• The meteorological support provided by the DMSU and Defence WSOs in all the above forms assists ADF personnel to run efficient and safer operations, whether they are located in areas of conflict overseas or engaged in exercises within Australia.

• The provision of services to visiting defence forces and to multinational exercises overseas also contributes to good relations between Australian and other defence forces in our region.